Cognitive Dominance and Brain Development

Michael D. Matthews
U.S. Military Academy
Department of Behavioral Sciences and Leadership
(Fellow, Army Chief of Staff's Strategic Studies Group, 2014-2015)

Release of this information does not imply any commitment or intent on the part of the U.S. government to provide any additional information on any topic presented herein. This briefing is provided with the understanding that the recipient government will make similar information available to the U.S. government upon request.

Cognitive Dominance: Historical Perspective

- Cognitive Dominance – Coined by the author in 2005 in support of MG (R) Robert Scales' vision of revolutionizing Army training.
- Definition: Dominating and winning engagements through superior and faster situational understanding and decision making.
- "Cognitive Dominance: Intuitive Decision Making in Military Leaders Workshop" held in Washington, DC

Cognitive Dominance: Historical Perspective

"I don't know what cognitive dominance is, but I want some!"

- LTG (P) Scott Wallace, September 2005

Cognitive Dominance: Historical Perspective

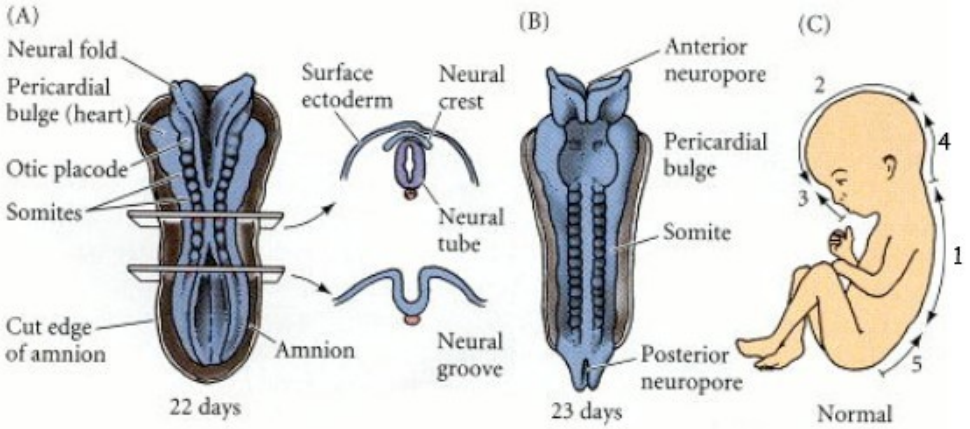
- Cognitive dominance, in its nascent stage, focused on intuition, naturalistic decision making, situational awareness, and tactical decision making.
- Intended outcome: Bloodless learning and tactical superiority.
- A natural evolution from COL Boyd's concept of the OODA loop.

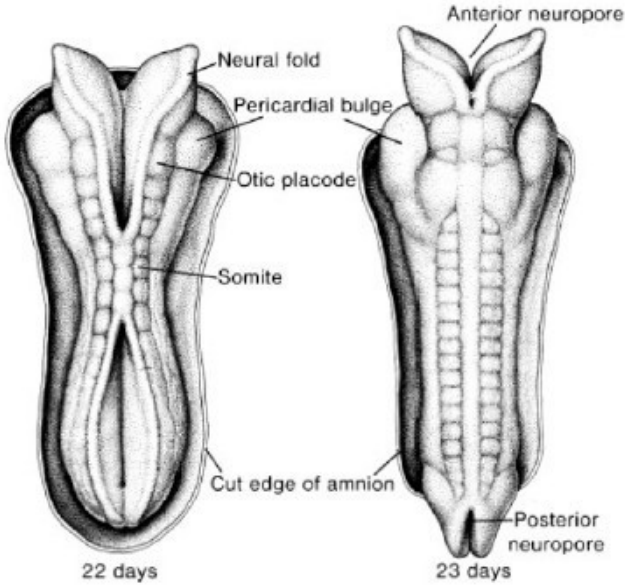
Cognitive Dominance: 2015

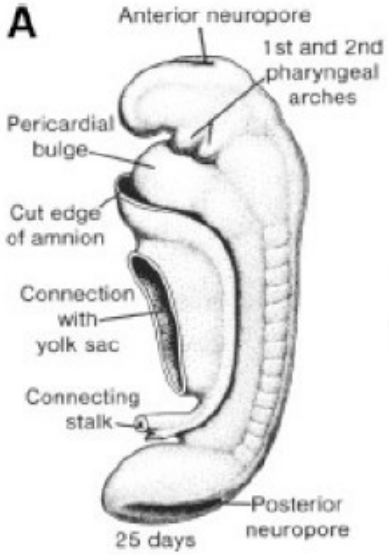
- Concept is broadened and more explicitly includes brain function.
- Outcome is still focused on military superiority, but expands beyond the tactical level.
- Cognitive processes (attention, memory, etc) are modulated by emotional and social processes, also linked to brain function.

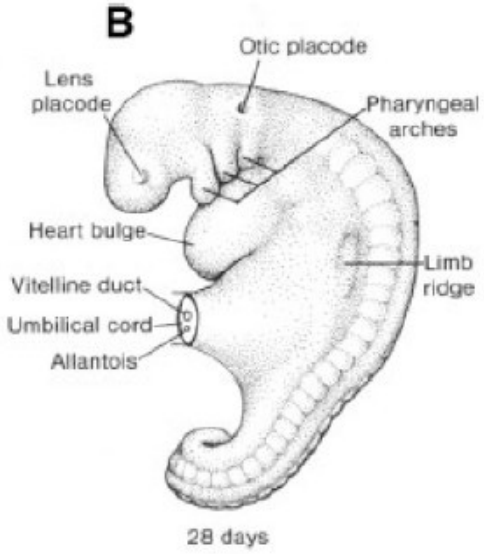
Cognitive Dominance: Brain Development

- CNS (brain and spinal cord) begin to
  emerge from the neural tube at two weeks post-gestational age.


(A)
Neural fold
Pericardial bulge (heart)
Otic placode
Somites
Cut edge of amnion
Surface ectoderm
Neural crest
Neural tube
Amnion
Neural groove
22 days
(B)
Anterior neuropore
Pericardial bulge
Somite
Posterior neuropore
23 days
(C)
2
3
4
1
5
Normal


Anterior neuropore
Neural fold
Pericardial bulge
Otic placode
Somite
Cut edge of amnion
Posterior neuropore
22 days
23 days

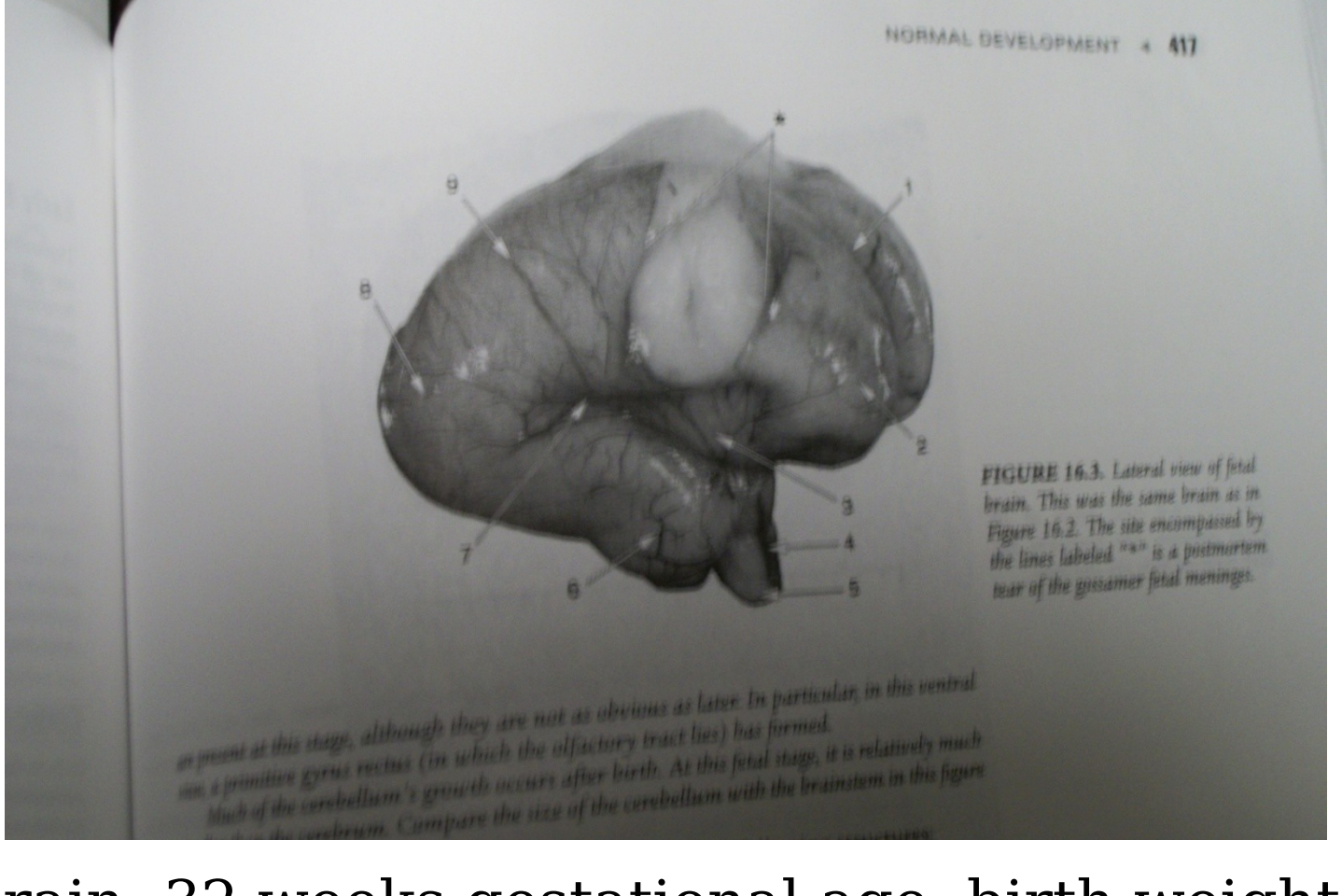

A
Anterior neuropore
1st and 2nd pharyngeal arches
Pericardial bulge
Cut edge of amnion
Connection with yolk sac
Connecting stalk
Posterior neuropore
25 days


B
Otic placode
Lens placode
Pharyngeal arches
Heart bulge
Limb ridge
Vitelline duct
Umbilical cord
Allantois
28 days

Cognitive Dominance: Brain Development

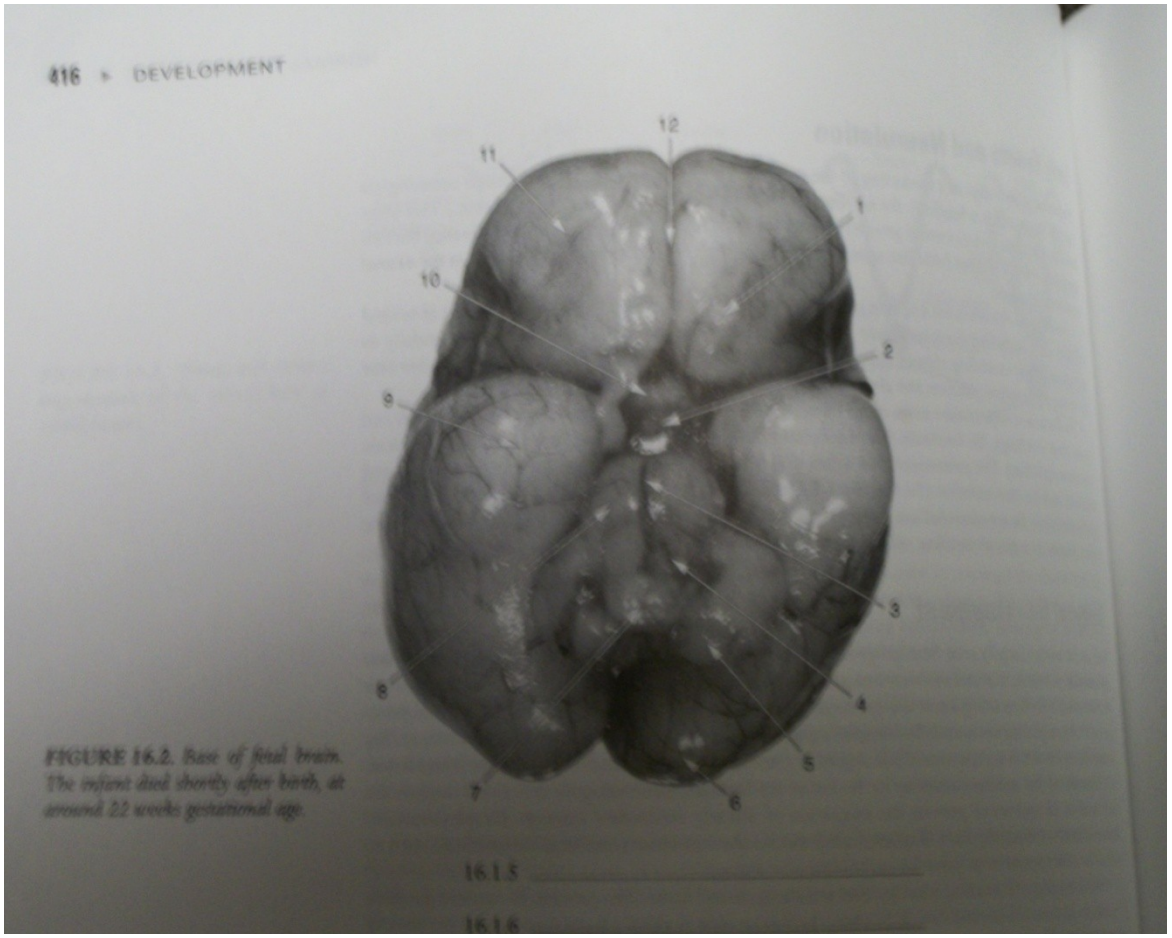
- Prenatal stages of brain development
  - Proliferation
  - Migration
  - Differentiation
  - Myelination
- Postnatal
  - (Synaptogenesis)
  - Pruning
  - Synaptic reorganization

Cognitive Dominance: Brain Development


NORMAL DEVELOPMENT 417
FIGURE 16.3. Lateral view of fetal brain. This was the same brain as in Figure 16.2. The site encompassed by the lines labeled "*" is a postmortem tear of the gossamer fetal meninges.

uman brain, 32 weeks gestational age, birth weight = 375 g

Cognitive Dominance: Brain Development



The Adult Brain

Adult brain, weight = 1375 grams

Cognitive Dominance: Brain Development

At birth

- Humans have the greatest number of neurons at or shortly before birth. This is reduced by;
  - Pruning
  - Apoptosis
- Some brain regions, notably areas of the frontal lobe, are not completely wired until age 25 (but do not overstate the impact).
- Adult brain development is primarily altering synapses.

Brain Development: Tuning by Experience

- Experience and dendritic branching
  - Enriched environment studies
- Brain reorganization
  - Language
  - Music
  - Focal hand dystonia
- Myelinated pathways and vigilance
  - UT Austin/USMA study

Brain Development: Implications for Cognitive Dominance

- Young (pre-age-25) brains are especially vulnerable to injury, with significant implications for mTBI, PTSD, CTE, etc.
- But the young brain may be more ready to develop the neural architecture needed for higher order thinking and decision making.
- There is no age at which the brain does not respond to environmental

Brain Development: Implications for Cognitive Dominance

- Commercial products that claim to strengthen cognitive function through relatively simple “brain exercises” are of questionable utility.
- Evidence suggests that interventions/exercises aimed at higher order thinking, metacognition, and attention allocation may have significant and

Building/Maintaining Cognitive Dominance

- Number one factor is physical exercise (and impact on sensory/motor brain components).
- Engaging in and practicing higher order cognition.
- Exposure to novel tasks and stimulation, but it must be challenging.
- Train for cognitive complexity, for example, in Army education emphasize developing an understanding of "wicked" problems and the systems

Building/Maintaining Cognitive Dominance

- Maintain a positive and enriched social network.
- Avoid self-inflicted injury (excessive alcohol consumption, overly routinized lifestyle, social isolation).
- Intentionally build the cognitive Rolodex, allowing for faster and more adaptive decision making.

Cognitive Dominance: Caveats

- There is no single, easy solution to ensure adult brain development.
- Neurochemistry is extraordinarily complex, so don’t expect a pharmacological solution anytime soon.
- Cognitive dominance is a joint function of genetics, environment, & personal history.
- Leaders only influence environment, and must foster an

Discussion/Questions